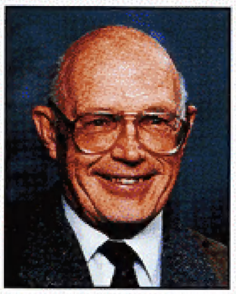
From the desk of...

A turbine that succeeds in stabilizing itself



Donald E. Bently
Chairman and Chief Executive officer, Bently Nevada Corporation
President, Bently Rotor Dynamics Research Corporation

Nearly all instances of the Fluid-Induced Instability Mechanism (Oil Whip, Steam Whip, etc.) result in a forward circular orbiting with an amplitude that increases as a function of load or rotative speed. This mechanism rapidly destroys seals and bearings and often results in full radial rubs. Figure 1 shows the typical forward spectrum cascade of such a machine.

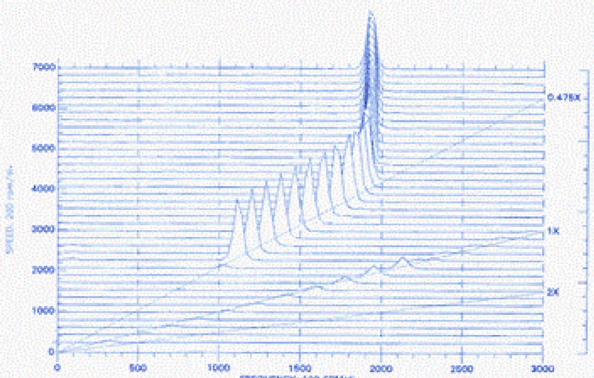


Figure 1
Typical forward spectrum cascade plot of a machine with a fluid-induced instability.

Sometimes, however, the good guys win! Figure 2 shows the forward spectrum cascade of a gas turbine that knows how to fix its own problem very successfully.

As can be seen, a subsynchronous forward circular whip begins at 3900 cpm when rotative speed reaches 8000 rpm. The whip is most severe at rotative speed of 10,000 rpm. Thereafter the forward circular subsynchronous whip gradually drops in amplitude so that it is last seen at 9600 cpm when the rotative

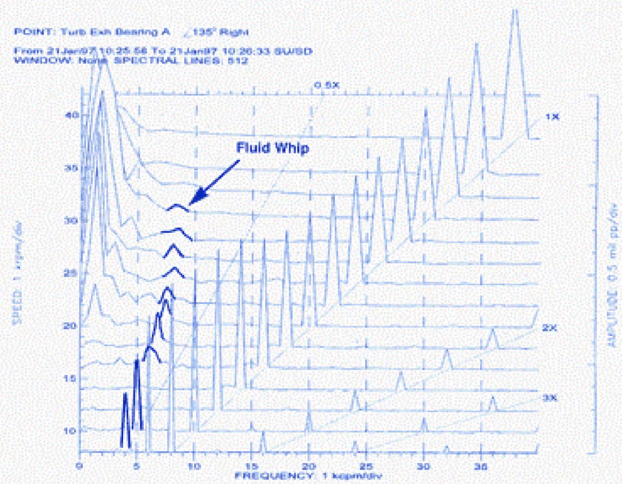


Figure 2
Forward spectrum cascade plot of the gas turbine-generator with fluid-induced whip.

speed is at 31,000 rpm. This whip is never again seen in any operating condition of the gas turbine.

What mechanism causes this whip to cease? I do not know, and since it works well and it is my machine, I really don't care. However, since the mechanism also applies to other machines, we had better know why the system stabilizes! Here are some possibilities.

1. The action at about 1800 cpm, which is the operating speed of the electric generator as well as its pivotal balance resonance speed (with its present support), is so large that the gas turbine shaft is at very high dynamic eccentricity in its bearings. This causes the Direct Dynamic Stiffness to be very high, as well as the fluid swirl ratio (of the sleeve bearing of the gas turbine) to be so low, that the rotor system is stable.

2. This gas turbine has floating sleeve bearings which have not been used on any other machine, to my knowledge, in the last 30 years, and these bearings have some attribute we have not yet noted.
3. The design of the gas turbine is such that a large, steady-state radial sideload is applied to the shaft so that, as the gas turbine comes up to speed, the shaft is pushed to very high eccentricity in the bearing, creating stability as in (1) above. This is reasonably confirmed by the shaft centerline plot of the "A" bearing in Figure 3. Without further information, I believe that this steady radial sideload is the stabilizing element.

I do not know if this gas turbine manufacturer deliberately designed the machine with this stabilizing feature, or if it just happened (like, "Did you play that card, or did it fall out of your hand?"). However, I would bet a lot of money that it was done deliberately, because this manufacturer has an excellent reputation. That's pretty good, because a third of a century ago, when it was built, only about 10% of the present knowledge on the fluid-induced instability was available.

Remember the ISROMAC Symposium coming up in February 1998 in Hawaii.

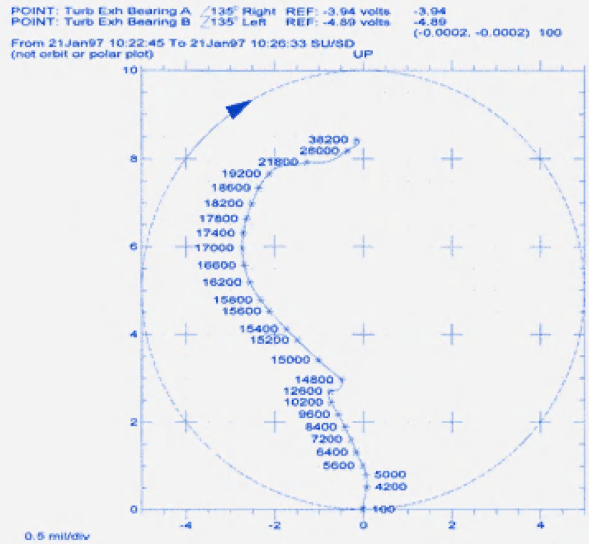


Figure 3
Shaft centerline plot taken during the startup of the gas turbine-generator

Donald E. Bently receives the N.O. Myklestad Award

The Technical Committee on Vibration and Sound (TCVS) of the American Society of Mechanical Engineers (ASME), has selected Donald E. Bently, Chairman and Chief Executive Officer of Bently Nevada Corporation, to receive the organization's prestigious N. O. Myklestad Award. Established in 1991, the award is presented in recognition of major innovative contribution to vibration engineering. TCVS informed Bently that the particular work for which he is being recognized is his original and widely known development of the eddy current probe.

In the garage of his Berkeley, California home in 1955, Bently pioneered an entire industry when he developed the world's first commercially successful eddy current proximity transducer system. Relocating to Minden, Nevada in 1961, his business continued to grow at a rapid rate, soon becoming the State's largest industrial employer. Today, Bently Nevada Corporation products and services are sold worldwide, helping the Company's customers operate more safely and efficiently. Bently Nevada Corporation is the world's leading supplier of monitoring and diagnostic products used by the petrochemical, power generation, pulp and paper, and other industries.

Bently's ongoing research continues to add to the knowledge of rotating machinery behavior. He has published more than 50 papers on the subject of rotating machinery diagnostics through vibration monitoring. Bently received a Bachelor of Science degree in Electrical Engineering with distinction and a Masters degree in Electrical Engineering from the University of Iowa. In 1987, he received an honorary Doctorate in Engineering from the University of Nevada, Reno. He has received numerous other awards and is recognized throughout the world as an authority in his field.

Bently has been invited to personally receive the award at the organization's Vibration Conference to be held in Sacramento, California, 14-17 September.

See You At
The 7th International Symposium on Transport Phenomena and Dynamics of Rotating Machinery

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